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Unprocessed Salvage Autologous Blood Transfusion for Managing Ongoing Massive Haemorrhage in Areas with Limited Blood Resources

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Abstract

Increasing shortages of allogenic blood and risks of transmitted infections have prompted the use of a range of blood sparing techniques associated with emergent surgery under specific circumstances . Salvage autologous blood transfusion (ABT) is a safe and feasible method for rapid blood volume replacement to correct haemorrhagic shock , usually from bleeding in body cavities or wounded extremities, in areas with limited or, even, non-existing blood donor resources, such as those of armed conflicts and natural or environmental disasters. Blood autotransfusion must be placed in the context of an early surgical approach to the haemorrhagic patient, either preoperatively or once the operation commences.

Keywords: Massive haemorrhage; Salvage autologous blood transfusion; Armed conflict field

Introduction

Autologous blood transfusion (ABT) was used for the first time in 1818 by James Blundell, a British obstetrician [1,2]. At the beginning of the 20th century, Landsteiner's classification of blood groups resulted in the widespread use of the allogenic donated blood as a standard practice in health care [2,3]. In modern times, after the development of cardiac surgery and the advent of highly sophisticated equipment, ABT has been "re-discovered" and is widely used in cardio-thoraco-vascular, transplantation, neuro- and orthopaedic surgery [2,4]. Scarce resources of allogenic donor blood, which worldwide exerts real social and economic pressure and the risk for viral/prion transmission have prompted the use of a range of blood sparing techniques in the perioperative period [3-5]. In armed conflicts and other situations of massive violence, where surgeons and rescue team work with limited or non-existing blood resources on the field, facing patients who are bleeding to exsanguination and death, either due to a severe but survivable injury (i.e., abdominal, thoracic, of the extremities) or acute rupture (i.e., on ectopic pregnancy), autotransfusion during urgent haemostasis can rapidly and safely replenish the patient's blood volume [2,3,6]. The International Committee of the Red Cross (ICRC, Geneva) and the Medicines Sans Frontieres (MSF) intentionally have the accumulated experience of emergent transfusion in high intensity war front lines and areas of natural disaster all around the world .

Discussion

In emergent cases, rapid loss of circulating blood volume results in a sharp drop in blood pressure, increase in heart rate, tissue hypoxia and weakness. If not treated promptly, it inevitably leads to haemorrhagic shock, as in cases with ruptured ectopic pregnancy accounting for about 9 % to 13 % of pregnancy-related

deaths [3,7]. Urgent surgical haemostasis and rapid blood volume replacement are the primary measures to save the trauma and obstetric patients [7].

Various methods and devices have been described for the collection of shed blood in open or closed systems and transfusing it to the same patient, having certain points in common, from very simple and improvised (i.e. ,on war fields) to highly sophisticated commercial ones [2,4, 8-11]. Blood is harvested into canisters/bags or reservoirs pre-, peri-, or directly post-operatively, by suctions, aspirators, drains or chest tubes (for haemothorax), from a body cavity (thoracic or abdominal) or a wounded extremity [2-5]. At present, there are three main methods of ABT, namely Cell Salvage (CS), Preoperative Autologous Donation (PAD), and Acute Normovolaemic Haemodilution (ANH) [3-5, 12]. CS is emerging as the preferred method for recovery type ABT, and an increasing amount of evidence is accumulating with respect to its safety and efficacy; PAD and ANH could be useful in some elective high blood loss procedures and rare blood groups [4,12,13].

The best auto transfusion technique for unstable patients in resource-limited conditions should be simple, safe and cheap, requiring no power supply and only minimal human resources [3,4]. The simpler method is generating unprocessed blood, which is crude shed blood collected promptly into a sterile container, filtered through multiple layers of gauze (6-8) or compresses (generally, one for the chest, two for the abdomen or limps), and returned directly to the patient [2,4,14]. Coverage with wide-spectrum antibiotics is always required, although experience has shown that infection after ABT (in the absence of cell-salvage technology) of even enteric-contaminated blood, filtered twice, is rare [2,14].

The need for anticoagulants (citrate phosphate dextrose adenine, CPDA) or heparin (500-1000 U per unit blood) when transfusing non-processed blood has been a subject of controversy [2]. However, it is accepted that, for blood retrieved from a haemothorax, which does not form clots because it is defibrinogenerated unless the haemorrhage is from the great vessels, the use of anticoagulant or heparin is probably not required; instead, for shed blood from large vessels, it is theoretically warranted, although clinically this has not always been proved [2,6]. In the peritoneal cavity, coagulopathy results from microaggregates of platelets, red blood cells (RBCs) and debris. Heparin as a better anticoagulant has been proposed in cases with activated coagulation cascade leading to disseminated intravascular coagulation (DIC). In blood collected from rupture of an ectopic pregnancy, the trophoblastic products could cause DIC [2]. In blood recuperated from fractured limbs, the microaggregates include fat globules that theoretically can cause fat embolism [2,5]. Of course, performing controlled clinical trials under circumstances with limited resources would be difficult.

Electively, processed blood is aspirated by the suction machine into an apparatus that adds an anticoagulant, then filters, and complementary provides a cell-washing stage and centrifugation, that dramatically eliminate all serum proteins, free haemoglobulin, platelets, clots, cell debris and the anticoagulant [2-4]. Only a concentrated RBC mass with a haematocrit of 50 % to 70 % returns to the patient [2,3,8]. These mechanical systems require specialised personnel. On the other hand, in case of ongoing massive abdominal haemorrhage (i.e., ruptured spleen or liver, ectopic pregnancy), intraoperative haemostasis from the surgeon comes first, while the abdominal cavity is cleared with a laparotomy suction of low pressure (or a “sump aspiration” device) to avoid haemolysis, handled by an operating assistant; the sterile collection bottle contains anticoagulant and normal saline to avoid clotting [2]. Otherwise, blood can be scooped into a basin or kidney dish with a sterile soup ladle, but this is time-consuming; this open method is usually used in case of haemorrhage from limbs. The recuperated blood is immediately filtered twice before transfusion. Specifically , the autotransfusion system in massive haemothorax (> 2000 ml) uses the intercostal chest tube that is connected to a re-sterilizeable chest bottle containing 100 ml saline (or, “in extremis”, a urine collection bag without saline), which, after filtering the blood, is inverted to become the administration set [2].

ABT is placed in the setting of a surgical approach to the haemorrhagic patient, which includes timely control of bleeding and meticulous haemostasis [9,15]. Based on the ICRC recommendations [2], in most bleeding patients whose evacuation is delayed and total blood loss is 1000 ml or more, but arrive in a relatively stable hypovolaemic condition, initial treatment requires basic resuscitation with I.V. crystalloids, plasma, and plasma expanders (if available) prior to surgery. In patients with acute and massive haemorrhage, the degree of urgency, the desperate need for blood transfusion to save them, and the lack of any other source of blood appears to define the deadline for ABT more than anything else [2,6,15]. In these cases, the rapid loss of over 20 % of estimated blood volume (i.e. ,1000 ml blood), or a haematocrit value of less than 35 % on admission with expected crystalloid requirements of more than 2000 ml, should alert the surgeon and anaesthetist for the need for possible autotransfusion [2,15]. The most common use has been for ectopic pregnancy and massive haemothorax. Other indications for ABT concern cases with substantial blood loss occurring either when the operation commences (usually, a laparotomy with ruptured spleen and packed liver ,and the bleeding control of wounded limps) or in the postoperative setting [2,3,12,14].

ABT lacks some important disadvantages of the allogenic blood transfusion, such as immunosuppression, transmission of diseases (including viral, such as hepatitis and human immunodeficiency, but also bacterial or parasitic), haemolytic reactions/technical errors in histocompatibility, scarcity of resources and uncertainty in patients with rare blood groups and multiple auto-antibodies [3,4,13,15]. On the other hand, autotransfusion may cause transient haematological abnormalities (i.e., coagulopathies, especially when more than three liters of unprocessed blood are given) and possibly febrile reactions that disappear within 72 hours [2,11]. One should also not forget that laboratory results (i.e., hematocrit) are influenced through the haemodilution from the synchronous rapid infusion of crystalloids.

Clinically, ABT has proven safe and effective as it has not resulted in significant increase of infectious complications, even with blood harvested from war wounds, which is obviously not sterile [2]. Other potential complications of ABT, reported but rarely causing significant risks, are haemolysis/haemoglobinuria with transient deterioration of renal function (treatment with aggressive hydration and urine alkalinization), electrolyte disorders, pulmonary hypertension and Acute Respiratory Distress Syndrome (ARDS) [3,4]. In the setting of the patient massively bleeding, with little or no blood available for homologous transfusion, the great benefits of ABT have proven to outweigh by far the possible risks, even of multiple organ dysfunction/ failure [2,15]. Finally, there are only a small number of studies indicating that reinfusion of fetal cells in salvage blood during caesarian section can be used without the complications of amniotic fluid embolism and rhesus sensitization [4]. Larger cohort-studies are certainly required.

Conclusively, in circumstances where blood for transfusion is scarce, recovery ABT for massive haemorrhage is time and lifesaving. ABT, as a simple method of blood replacement requiring no specific equipment, is placed in the setting of the emergency approach to the haemorrhagic patient ,which includes timely control of bleeding and haemostasis .

Conflict of Interest

None declared.

Authors' Contributions

EA-reference research, manuscript submission; DJ (MSF surgeon in conflict areas)-manuscript conception; CA-manuscript conception, design, writing.

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